Leaflet 13

Energy savings in schools – energy conservation measures in temporary classrooms

- Occupancy sensing controls make significant energy savings with predicted payback of 1-2 years
- Reliable controllers with optimum start save an estimated 48% of previous consumption
- Charge controllers fitted to storage heaters repaid investment in only 2 months

This General Information Leaflet describes how some improvements were made to the controls in different schools to reduce heating costs for the three most common forms of heating – direct electric heaters, electric storage heaters and gas room heaters.

Introduction

Many schools use 'mobile' buildings as part of their accommodation, either as full time classrooms or for specialised activities such as music lessons. While they provide useful space on a temporary basis, these classrooms are generally poor energy performers and, if used over the long term, can result in high energy costs being incurred.

The running costs of temporary classrooms should always be taken into account when considering their purchase and continued use. Where they are used, the buildings should be selected so that they meet current Building Regulations standards for energy efficiency.

Whenever possible, gas heating should always be chosen in preference to electric heating, and electric storage heating should be avoided. A good level of control of the heating system is necessary. The form of construction and age of temporary classrooms vary but most have the following factors in common:

- low levels of insulation
- large glazed areas
- very lightweight construction and a consequent tendency to suffer from temperature extremes
- high surface area to volume ratios (often with heat loss from all six sides)
- location in exposed positions (eg on the edge of the sports field).

Consequently:

- the buildings overheat in summer and cool down rapidly in winter, and
- are expensive to heat for the size of accommodation provided.

Occupancy sensing controls and electronic thermostats

Introduction

West Sussex County Council (WSCC) has about 700 temporary classrooms, the majority of which are heated using mains gas. Most of the remainder use on-peak electricity. WSCC prefers gas, since, for the same degree of control, gas heated classrooms cost about one-third as much to heat as those with on-peak electric heating.

In the temporary classrooms where there was no alternative to on-peak electric heating, the Council wished to reduce the high running costs.

In 1990, WSCC carried out a pilot study to evaluate the cost-effectiveness of fitting improved controls to electric heaters. Good results from this study led to installation of the controls in all 170 of its electrically-heated temporary classrooms.

"How temporary classroom heating costs can be cut by effective use of controls"

BEST PRACTICE PROGRAMME

Energy Efficiency Office
DEPARTMENT OF THE ENVIRONMENT

SENSING CONTROLS AND THERMOSTATS

Two temporary classrooms at Durrington Middle School were used to assess the savings from occupancy sensing controls on the heating

Annual savings £	Installed cost/class £	Payback period years
124	140	1

Table 1 Durrington middle school pilot scheme

Annual savings (based on pilot) £	Installed cost/class £	Payback period years
124	330	1-2

Table 2 Council programme following pilot

Note: Insulation standards in temporary classrooms elsewhere may be considerably poorer and installed heating capacity less than at West Sussex. This will increase the time taken to reach the desired room temperature and may make it necessary to use higher set-back temperatures.

Pilot Study

Durrington Middle School in Worthing was chosen as the site for the study. Controls were fitted in two temporary classrooms. Each classroom had four 3 kW convector heaters, originally controlled by a room thermostat and a 7-day timeswitch, without any 'night set-back' facility.

The new controls consisted of a passive infra-red occupancy sensor and an electronic thermostat incorporating a time-delay and set-back facility. Prior to occupation at the start of the school day, the room was brought up to the set-back temperature. When the classroom was occupied, as detected by the sensor, the room was brought up to its desired setting, which took around 15 minutes. If the room became unoccupied, the temperature was allowed to fall to the set-back temperature after a pre-set delay. The process was repeated every time the room was occupied and vacated. At the end of the day the timeswitch turned off the heating.

For the trial, the desired temperature was set at 19°C with the set-back at 12°C (the possible range is 10°C to 14°C). The time delay of 10 minutes was chosen from the range of 5 to 60 minutes.

Energy costs and savings

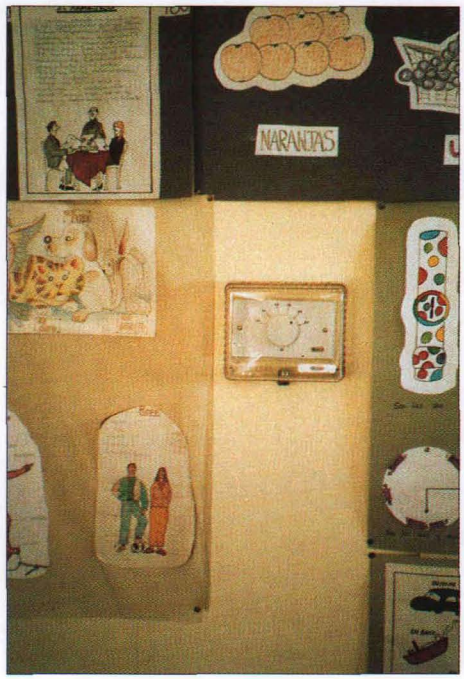
The two classrooms were monitored in March 1990, before and after fitting the new controls. A 70% reduction in electricity consumption was recorded, worth about £7.75 per week. Not all of this saving can be attributed to the new controls alone, some is likely to be due to previously poorly set controls. Based on a 32 week heating season, annual savings due to the new controls are likely to have been at least £124, half the total savings. With an installation cost of £140 per classroom (1990 prices), this gave a payback period of a year.

Replication

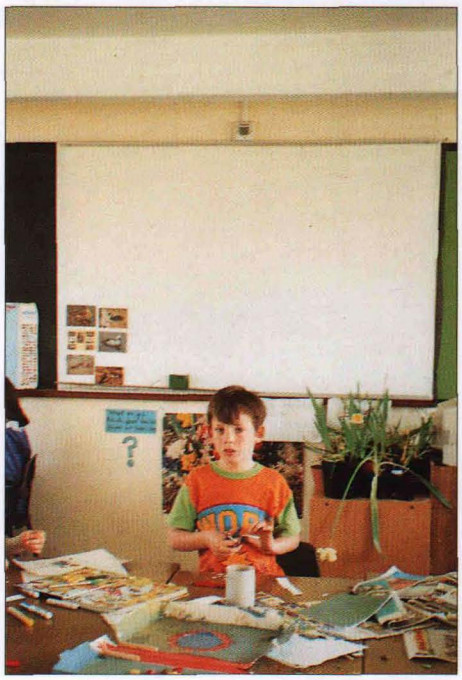
As a result of the highly successful pilot scheme, the Council initiated a three month programme to install these controls in all its electrically-heated classrooms. The controls installed were the same as those in the trial, but with the set-back temperature usually set at 14°C. The occupancy sensor was generally above the blackboard. The thermostat, fitted with a clear tamperproof cover, was located 1.5 metres above floor level.

The whole programme gave an average cost of £330 per classroom. The works included replacement of some timeswitches and any necessary rewiring. Based on savings in line with those in the pilot scheme, but allowing for the higher set-back temperature, the average payback period is 1-2 years.

A few complaints of underheating were reported following the installation of controls, but these were due either to incorrect setting of the timeswitch, or to occupants being used to temperatures of more than 19°C. In addition, some faulty heaters were identified – it took up to an hour for a classroom to reach its desired temperature. All faults were rectified, and



A tamperproof box protects the electronic thermostat which incorporates the options for the set-back temperature and timed delay



The occupancy sensor, located above the white board, lets the room fall to the set-back temperature if the classroom is unoccupied

during the first full heating season (1991-92), the Council received no complaints of underheating from the classroom users. This emphasises the importance of full communication with, and involvement of, the building occupants.

The controls are equally suitable for gas heaters, and WSCC now has a policy to fit these controls in all new temporary classrooms, whether gas or electrically heated, the extra cost being only £170 (1992 prices). The Council also intends to fit the occupancy sensors and controls in existing temporary classrooms which are heated by gas. Due to the cheaper running costs of gas heaters the payback periods are expected to be in the region of 5 to 6 years.

General comments

Initially some teachers considered the time taken to bring the classrooms fully up to temperature to be too long, even using the highest set-back setting of 14°C. WSCC reported this to the manufacturers, who responded by bringing out another model with a higher set-back temperature range of 15°C to 19°C. Payback periods are therefore longer than in the earlier schemes. Other manufacturers produce similar equipment, but with occupancy sensors which operate by detecting noise instead. With some systems, lighting control based on occupancy detection may also be incorporated. (See EEO Good Practice Case Study 95.)

Electronic time and temperature controls

Introduction

Humberside County Council owns 200 temporary classrooms, all of which were heated by on-peak electricity. Improved heating controls were fitted to all of these classrooms after a pilot study established the cost-saving potential.

Pilot study

The study was carried out in 1986 in three identical temporary classrooms at Humberside College of Further Education in Driffield. Each classroom was heated by four 2 kW convector heaters, originally controlled by a single room thermostat and timeclock.

- The first classroom was fitted with a controller with optimum start – an optimiser.
- The second with a phase controller.
- The third was left with the original controls.

The optimiser control maintained required temperatures in the classroom by turning the heaters on and off. The phase controller varied the output from the heaters by modulating the waveform of the power supply.

Monitoring showed that both methods of improved control gave similar savings of between 2 to 3 years. An even better payback of just over 1 year could be achieved by using a single controller for double classroom units.

The phase controller gave more even classroom temperatures, but the controller was felt to be relatively new and untried and had some drawbacks. In particular it caused the convector heaters to 'sing' at low power levels. The optimiser control offered close control over internal temperatures (±0.5°C) accurate time control and optimum start based on internal temperatures. It had proven reliability and extra features, including the options of frost control, and an override for out-of-hours use. Another attraction of this controller was that, if necessary, it could be moved and used elsewhere and was compatible with any heating system, whereas the phase controller was fixed to a specific electric heater.

Replication

As a result of the trials, when temporary classrooms were relocated, the Council's Energy Unit began a programme of installing the controller with optimiser together with improving insulation standards.

They used a number of types of controller over the years, and in 1991 the Energy Unit standardised on a new controller. It was manufactured by the same company as the authority's preferred boiler optimisers. The particular features of the new controller are:

- an accurate integral timeclock
- room temperature setting (range 12°C to 24°C)
- minimum temperature setting (to provide frost protection if necessary)
- an extension timer (for out of normal hours use).

This unit operates in conjunction with an accurate, remote electronic temperature sensor within the classroom.

Once the settings have been chosen, only a keyholder can alter them. However, the classroom user can still select either the fixed override period or holiday mode.

The new controller, having accurate tamperproof control and fixed override timer for out-of-hours use, is similar to the improved controller used in the original study. It does not include optimum start, as experience showed that the quick response of the electric heating system could bring the thermally lightweight classrooms up to the set-back temperature in about 20 minutes. Therefore simpler control with fixed time start was acceptable, and similarly energy efficient.

In all cases, the close control achieved over internal temperatures was greatly appreciated by the building users.

Energy costs and savings

In 1992, the average cost of heating a temporary classroom in Humberside was £718 per year. Based on previously measured savings of 48%, and a combined purchase and installation cost of £550 (1992 prices), the payback period on fitting the new controllers was between 1 and 2 years.

General comments

Following Humberside CC's use of the heating controller in temporary classrooms, the manufacturer has brought out another simpler model specifically for use in these types of building. The purchase price of this was £280 in 1992, which offers a much reduced payback.

More sophisticated models, incorporating optimum start control on the preheat period, may be required for schools with structurally heavyweight buildings.

A heating controller connected to an electronic temperature sensor within the classroom controls the on-peak electric heating in Humberside County Council's temporary classrooms

Annual savings/ classroom £	Installed cost/controller £	Payback period years
260	600	2 – 3

Table 3 Humberside College of Further Education pilot scheme

Annual savings £	Installed cost £	Payback period years
350	550	1 – 2

Table 4 Humberside County Council programme following pilot

Weather compensating controls for storage heaters

Introduction

In 1992 Essex County Council had almost 1050 temporary classrooms, which were used to provide accommodation for schools and colleges with fluctuating pupil numbers.

The majority of these classrooms were heated by off-peak electricity; 900 were fitted with single, large (9 kW rated) fan-assisted storage heaters. Most of the newer classrooms had several domestic-sized storage heaters instead and some use was also made of mains gas for heating.

As a general rule, the low thermal capacity and high heat loss of many temporary classrooms mean that storage heaters are an inefficient way of heating this type of building.

TEMPORARY CLASSROOMS

In the late 1980s, the Council was successful in attracting European Community funding for a major research programme to examine alternative conservation measures. As a result, 85 of its temporary classrooms were monitored over a year, using hours-run meters (recording the time electricity was being used) to establish their fuel consumption for heating. Conservation measures were subsequently introduced into selected classrooms, and their effects monitored.

Pilot scheme

In December 1988, weather compensating charge controls were fitted in temporary classrooms at two primary schools, to evaluate the savings due to reduced overnight charge during milder periods.

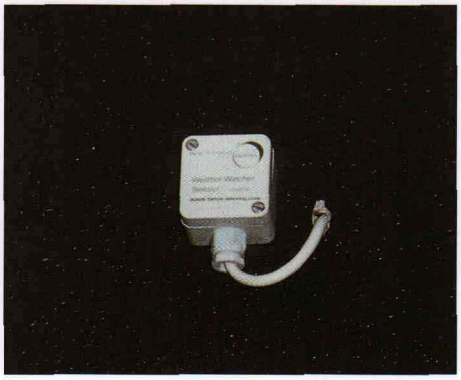
- At Harlow Katherine's Primary School, the controls were fitted in one single and two twin classrooms.
- At Harlow Sumners Primary School, the controls were fitted in 14 classrooms.

The controller saves energy by restricting the charging period according to readings from an external temperature sensor. For example, if only four hours of charge rather than the full seven hours are necessary, the charge limiter delays the start of charging until 0300 h.

Costs and savings

Using charge limiters and adjusting timeclocks where necessary ensured well controlled operation of the heating in the temporary classrooms at both sites.

Heating consumption originally varied greatly between classrooms. The range of heating consumptions was subsequently much narrower. Monitored data from 1989 (shown in table 5) compared to the previous year (weather-corrected) show payback of around 1 year in the first school and around 4 months in the second, for an installed cost of £123 per charge controller.



A sensor mounted on the outside of the classroom measures the external temperature

At Harlow Sumners, the design of the heating in the fourteen classrooms was such that only one charge controller was required per pair of classrooms. With a saving for the two classrooms of £620 per year, the payback at this site was only two months. The controllers also ensured more even internal temperatures, particularly at the beginning and end of the heating season, without the need for the user to adjust settings or (more commonly) to open the windows.

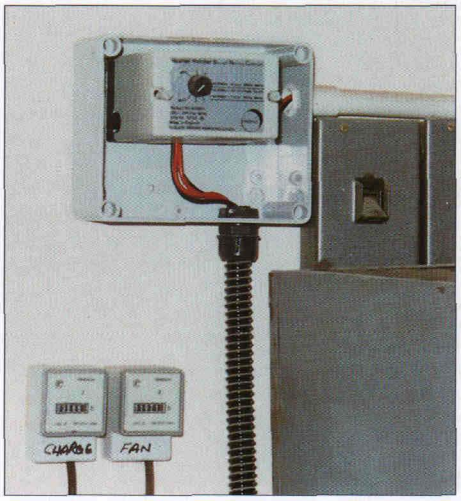
The Energy Unit at Essex CC was delighted with the results, and is now fitting charge controllers into other temporary classrooms. By 1992, around 50 charge controllers were in use in temporary classrooms.

Monitoring of temporary classrooms with gas heating systems, shows that the annual cost for an equivalent classroom heated by gas was £190. This shows the lower running costs that can be achieved using gas heating.

	Weather compensating charge controls fitted to:	Average reduction in consumption kWh/yr per classroom	Average reduction in costs per classroom per year £	Installed costs £/class	Payback period
Harlow Katherine's	1 single and 2 twin classrooms	2355	104	123	1 year
Harlow Sumners	14 classrooms	7022	310	62*	2 months

*Only one charge controller was required per pair of classrooms.

Table 5 Savings and payback at two Harlow schools



To reduce off-peak electric consumption the charge controller limits the charge accepted by the heater depending on the external temperature measured by a sensor

Summary

The lightweight construction and age of many mobile classrooms together with poor control of heating can result in excessive energy consumption. Although heating systems and fuel types vary, a review of the heating control strategy is likely to pay dividends. A range of modern reliable and accurate controls is available to satisfy individual requirements and budget limitations. This Case Study has shown that whichever heating system is employed, there is usually potential for simple low cost improvements that can result in return on investment in under two years.

Further reading

Other Case Studies in this series include the following.

Good Practice Case Study

94	Building Energy Management Systems
95	Energy efficiency in schools. Local controls for heating and lighting
99	Energy management by a school governor
100	A teacher as the focus for energy efficiency
101	Some simple energy conservation measures
184	A head teacher speaks out
185	Out-of-hours use of schools

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